

# Developing and Optimising a Closed-Loop Control System for Pitch Control on the MERIT Whirl Tower to reduce Eigenfrequency Excitation

## Project Outline

The MERIT test rig is a whirl tower featuring an 85kW motor and constant-rpm control, capable of monitoring rotor blade behaviour in a variety of extreme flight conditions, most notably deep dynamic stall. Currently the swashplate, i.e. the blade pitch can only be controlled via an open-loop control system, however the exact pitch angle can be measured to  $\pm 0.05$  degrees using hall sensors, presenting the opportunity to develop a PID controller that would close that loop. These pitch angles can also be used to influence the behaviour of the entire test rig; for example, if operating at an RPM where an eigenfrequency of the frame is being excited, the controller could be tuned to pitch the blades such to avoid the excitation of this mode as far as possible. This is particularly useful e.g. during start-up, where we inevitably need to pass through RPM where eigenmodes are excited.

## Project Plan and Milestones

- Literature review on rotor PID controllers and eigenfrequency reduction using pitch control
  - **MS1:** Expose outlining project
- Familiarisation of DAQ software (LabVIEW) and swashplate control software (Kollmorgen)
  - **MS2:** Establishing contact between the two systems
- Development of PID Controller
  - **MS3:** Implementation of controller during operation
- Quantifying excitation of eigenfrequency using accelerometers the effect that blade pitch has on this
  - **MS4:** Recognise eigenfrequency excitation during start-up
- Implement closed-loop-control to reduce the excitation of eigenmodes
  - **MS5:** Successfully reduce amplitude of excitation during start-up

## Prerequisites:

Understanding of control systems  
German language beneficial (not required)

Basic understanding of rotor dynamics



Fig 1: The MERIT Test rig, without blades attached

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